Coastal Mixing

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LONG TERM GOALS

I seek to understand the mechanisms of turbulence and mixing in shallow water sufficiently well to be able to specify useful parameterizations for coastal circulation models.

OBJECTIVES

I believe that this goal can best be achieved through a combination of comprehensive measurement of the turbulent fluctuations, the larger scale flows that drive them and modeling. The short-term objective (2000-2001) is to make such measurements in the Oregon upwelling system.

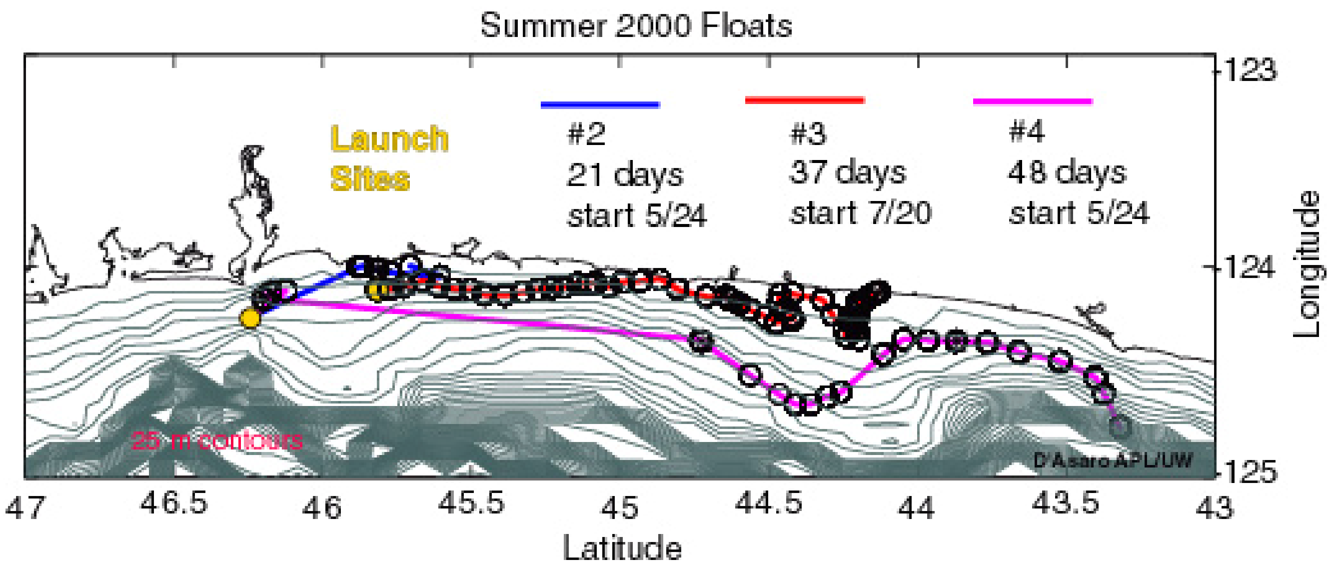
APPROACH

My technical approach is to use neutrally buoyant Lagrangian floats to measure water parcel trajectories that trace the path of mid-shelf water as it moves upward and shoreward in the upwelling circulation. High frequency measurements by the floats will measure the mixing dynamics along this path.

During the last decade, I have developed a new type of neutrally buoyant float (see picture) designed to be used in energetic turbulent flows such as those found in the top and bottom boundary layers of the ocean. A combination of accurate ballasting, compressibility matched to that of seawater and high drag is used to make these floats follow the motion of water parcels accurately. The floats measure their depth and are acoustically tracked in the horizontal and thus produce measurements of vertical and horizontal velocity. A new type of these floats was used for the first time in the 2000 Oregon upwelling measurements. These can operate both as Lagrangian floats, by varying their buoyancy to become neutrally buoyant and opening their cloth drogue to create a large drag and as vertical profilers, by folding the drogue and varying their buoyancy to profile up or down. They measure temperature and salinity of the water surrounding them (using a CTD) and the distance from the bottom (using an acoustic altimeter). At the top of each profile (once or twice a day) they obtain a GPS fix and telemeter data by the ORBCOMM satellite system. The float behavior can be adjusted by sending commands to the float via satellite.

WORK COMPLETED

Three Lagrangian floats were constructed (supported by the DURIP) and deployed in the spring/summer of 2000. All three worked, were recovered and returned good data. The figure shows the horizontal trajectories of each float. The first two floats (#2, #4) were deployed off the mouth of the Columbia River in May and recovered by the *R.V. Wecoma* in July. The GPS data is patchy due both to an insufficient height t of the GPS antenna and very fresh water from the river. These floats also suffered from a resonance between the control system, which aimed to hold them at a constant isohaline, and the semidiurnal tidal strain. This resulted in a vertical oscillation. This was tamed by changing the control parameters by satellite command. The third float (#3) was launched south of the river plume in July. Communication was lost after one day probably by an interaction with a fishing boat. The float appeared on a beach in late August and was recovered up a 120 ft cliff by muscle power. The data was of high quality.



RESULTS

Analysis of this data has only begun. However, several results are apparent immediately:

- All three floats upwelled from mid-shelf (100m water depth) to very near the shore as expected. One upwelled all the way to the surf zone. These are the first Lagrangian observations of upwelling. Generally, the floats moved into shallower water during "upwelling favorable" winds and into deeper water during "downwelling" winds, again as expected.
- A vigorous internal wave field was apparent on the shelf, dominated by nonlinear tidal and solibore motions.
- Preliminary spectral analysis suggests intermittent strong mixing.
- The upwelling environment is relatively friendly to floats. Fears of fatal interactions with crab pots and the bottom were unfounded, although beach recovery may be occasionally necessary.

IMPACT/APPLICATIONS

We expect to obtain significant new insight into mixing processes and parameterization on the shelf, particularly in the poorly studied inner shelf. We have also demonstrated the feasibility and usefulness of floats for studying the upwelling circulation and expect this to yield many new insights in the future.

TRANSITIONS

None

RELATED PROJECTS

These floats are close relatives of those used to study deep convection in the Labrador Sea funded by ONR 322OM. The same instruments are being used to study upper ocean mixing processes under NSF support and will be used to study hurricanes as part of the CBLAST program. Mixing processes in these various environments are similar in many ways and we learn the most by comparing and contrasting them.

PUBLICATIONS

E. A. D'Asaro and R.C. Lien, 2000, Lagrangian measurements of waves and turbulence in stratified flows, *J. Phys. Oceanogr.,* Vol. 30, No. 7, pp. 1669–1678

E. A. D'Asaro and R.C. Lien, 2000, The wave-turbulence transition in stratified flows, *J. Phys. Oceanogr.* Vol. 30, No. 3, pp. 641–655.